INTERNATIONAL JOURNAL OF PLANT PROTECTION | VOLUME 6 | ISSUE 2 | OCTOBER, 2013 | 257-261

IJPP

RESEARCH ARTICLE

Efficacy of triazole fungicides in controlling fruit rot of chilli

■ C.T. KUMBHAR* AND S.M. MORE

Zonal Agricultural Research Station (Sub-montane Zone), KOLHAPUR (M.S.) INDIA

ARITCLE INFO

Received : 24.01.2013
Revised : 07.05.2013
Accepted : 10.05.2013

Key **W**ords :

Capsicum annuum, Colletotrichum capsici, Fruit rot of chilli, Triazole fungicides

ABSTRACT

Field experiments were conducted for three consecutive *Kharif* seasons of 2009, 2010 and 2011 at the experimental farm of Zonal Agricultural Research Station (Sub-montane Zone), Shenda Park, Kolhapur, to study the efficacy of five fungicides of triazole group *viz.*, tebuconazole 25.9% EC, difenconazole 25% EC, hexaconazole 5% SC, tricyclazole 75% WP and propiconazole 25% EC against fruit rot disease of chilli caused by *Colletotrichum capsici*. Performance of these triazole fungicides was compared with mancozeb 75% WP, propineb 70% WP, copper oxychloride 50% WP and carbendazim 50 WP. Fungicide, tebuconazole appeared the most effective amongst the fungicides tested, with reduction in fruit rot incidence and intensity to the tune of 69.96% and 73.56%, respectively over unsprayed control, followed immediately with similar efficacy by other two triazoles *viz*., difenconazole and hexaconazole. Highest dry fruit yield of 25.91 q ha^{-1} was recorded in the plots sprayed with tebuconazole and was at par with that obtained in difenconazole, hexaconazole, tricyclazole, propineb and mancozeb sprayed plots. Although, the maximum increase in yield was obtained by spraying tebuconazole, the maximum benefit:cost ratio was obtained with hexaconazole. It means that tebuconazole though increases the yield, the cost of fungicide could not be yet met out with the increased yield. Conclusively, the present investigation reveals that four sprayings of fungicide, hexaconazole 5% SC at the concentration of 0.1%, first in the early fruiting stage and subsequent three sprays at 14 days' interval, are most effective and economical for controlling fruit rot disease of chilli under Maharashtra conditions.

How to view point the article : Kumbhar, C.T. and More, S.M. (2013). Efficacy of triazole fungicides in controlling fruit rot of chilli. *Internat. J. Plant Protec*., **6**(2) : 257-261.

***Corresponding author:**
Email: chandrakumbh@yahoo.com

INTRODUCTION

Chilli (*Capsicum annuum* L.) cultivation has existed for several hundred years as a sustainable form of agriculture in India and in many other countries. It is an annual herbaceous vegetable and spice grown in both tropical and sub-tropical regions. It is key ingredient of our Indian cuisine because of its pungency, colour and aroma. The crop is grown all over India having 75% of its area and production in the states of Andhra Pradesh, Karnataka and Maharashtra. India accounts for 25% of the world's total production of chilli. The sustainability of chilli-based agriculture is threatened by a number of factors. The crop suffers from many diseases such as damping off, anthracnose or fruit rot, dieback, wilt, leaf spots, powdery mildew and mosaic. Anthracnose disease due to *Colletotrichum* species, bacterial wilt caused by *Pseudomonas solanacearum* and mosaic disease caused by chilli veinal mottle virus (CVMV) or cucumber mosaic virus (CMV) are the most destructive diseases of chilli, which have been reported to impair the crop productivity (Isaac, 1992).

Anthracnose or ripen fruit rot disease of chilli caused by *Colletotrichum capsici* (Sydow) Butler and Bisby is a major problem in India and is one of the significant economic constraints to chilli production worldwide, especially in tropical and sub-tropical regions (Than *et al*., 2008). The disease is mainly a problem on mature fruits, causing severe losses due to both pre- and post-harvest fruit decay (Hadden and Black, 1989; Bosland and Votava, 2003). Chilli anthracnose usually develops under high humid conditions when rain occurs after the fruits have started to ripen with reported

losses of up to 84% (Thind and Jhooty, 1985). Pakdeevaraporn *et al*. (2005) have reported yield losses of up to 50% due to the disease. Economic losses caused by the disease are mainly attributed to lower fruit quality and marketability. Typical anthracnose symptoms on chilli fruit include sunken necrotic tissues, with concentric rings of acervuli. Even small anthracnose lesions on chilli fruits reduce their marketable value (Manandhar *et al*., 1995). Although infected fruits are not toxic to humans or animals, severely affected fruits showing blemishes are generally considered unfit for human consumption. This is because the anthracnose causes an unpleasant colour and taste in chilli products. Studies conducted on resistance aspect of this disease show very little resistance in chilli germplasm which indicate the presence of diverse population within the fruit rot/dieback or anthracnose fungus. Management of the disease under the prevailing farming systems in India has, thus, become a recurrent problem to chilli growers. The disease can be kept under check with chemical spray programme (Kadu *et al*., 1977; Thind and Jhooty, 1987; Datar *et al*., 1990; Sharma and Thakore, 1999; Rathore, 2004) but the complete control is still intractable. Triazoles are known to be broad spectrum fungicides with high efficacy at lower doses against different diseases on diverse crops (Schultz and Scheinpflug, 1988). Hence in the present investigation efficacy of some triazole fungicides was compared with that of fungicides recommended in the state of Maharashtra for management of the fruit rot disease of chilli.

MATERIAL AND METHODS

Field experiments were conducted for management of fruit rot of chilli incited by *Colletotrichum capsici* (Sydow) Butler and Bisby, for three consecutive years in *Kharif* season of 2009, 2010 and 2011 at the experimental farm of Zonal Agricultural Research Station (Sub-montane Zone), Shenda Park, Kolhapur of Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra, India). Five fungicides of triazole group *viz.*, tebuconazole 25.9% EC, difenconazole 25% EC, hexaconazole 5% SC, tricyclazole 75% WP and propiconazole 25% EC were evaluated at 0.1% concentration against fruit rot disease of chilli. Performance of theses triazole fungicides was compared with other fungicides recommended by the State Agricultural Universities of Maharashtra *viz.*, mancozeb 75% WP @ 0.25%, propineb 70% WP @ 0.15% and copper oxychloride 50% WP @ 0.25% (More, 2002; Anonymous, 2009). Moreover, carbendazim 50 WP @ 0.1% was also included in the study for comparison with these fungicides, which was tested as a standard fungicide for comparison with the fungicide iprobenphos by Sharma and Thakore (1999).

Twenty-five days old chilli seedlings (cultivar Phule Jyoti) raised in nursery bed were transplanted to 5.40 m x 3.15 m size experimental plots, maintaining a row spacing of 60 cm with 45 cm between plants in a row. Each treatment was replicated thrice adopting randomized block design. Fertilizer @ 100 kg N, 50 kg P_2O_5 and 50 kg K_2O was applied. Half dose of N and full doses of P_2O_5 and K_2O were given at the time of transplanting and remaining half dose of N was given 30 days after transplanting. Insect pests were managed with the use of recommended insecticides. Experimental plots were kept weed free by regular hand weedings.

A total of four sprays of triazole fungicides were given at 14 days' intervals starting from early fruiting stage of the crop. Rest of the fungicides under study were sprayed as per the recommendations, wherein propineb was sprayed for six times at 15 days' interval starting from 25 days after transplanting and; mancozeb and copper oxychloride were sprayed thrice at 15 days' interval starting forthwith from appearance of the disease symptoms. Carbendazim was sprayed three times as per the schedule followed by Sharma and Thakore (1999), where the first spray application was given at initiation of the disease and rest three were given at 15 days' interval. Each spray was given by using 500 l of fungicide solution per hectare with the help of knapsack sprayer. Unsprayed plots served as control. Data on fruit rot intensity were recorded by rating 25 fruit subsamples from total harvest of each replication by using 0-5 scale followed by Kaur *et al*. (2005) and from this per cent disease index (PDI) was calculated using standard formula (McKinney, 1923). Fruit rot incidence was calculated by counting number of diseased fruits in 100 fruit subsamples from the total harvest of each replication (one single lesion in pod was treated as disease occurrence). Yield data were pooled from all the harvests of each plot and the economics of spray operations was calculated.

RESULTS AND DISCUSSION

The results obtained from the present investigation are summarized below :

Fruit rot intensity and incidence :

Data given in Table 1 revealed that intensity of fruit rot in all the test chemicals was significantly low over check. Among all the fungicides, tebuconazole, difenconazole and hexaconazole proved to be most effective in reducing fruit rot intensity wherein lowest 17.16, 19.29 and 20.80% disease intensity, respectively was recorded as compared to highest 64.89% in untreated control. Reduction in disease intensity with these fungicides ranged from 67.95 to 73.56%, over untreated control.

Pooled data summarized in Table 1 revealed that the incidence of fruit rot in all the test fungicides was significantly low over check. However, least incidence of fruit rot was recorded in plots receiving sprays of tebuconazole with the disease control of 69.96%, followed immediately with similar efficacy by other two triazoles *viz.*, difenconazole and

hexaconazole with reduction in fruit rot incidence to the tune of 65.30 and 62.17%, respectively over unsprayed control. These were next followed by tricyclazole with disease control of 51.84% over unsprayed control. Propineb and mancozeb appeared the next best fungicides with disease control of 41.64 and 40.36%, respectively.

The present findings are in agreement with those of Chander Mohan *et al*. (2004) who reported significant control of fruit rot disease of chilli by tebuconazole, difenconazole and hexaconazole under laboratory as well as field conditions. Gopinath *et al*. (2006) reported dramatic reduction in anthracnose disease of chilli by spraying propiconazole (0.1%, 0.05%, 0.025% a.i.). Dithiocarbamates like mancozeb and propineb are already known for their efficacy against fruit rot disease of chilli (Jharia *et al.*, 1977; Chander Mohan *et al*., 2004). Efficacy of carbendazim against the fruit rot pathogen was reported by several workers (Mishra, 1988; Datar *et al*., 1990; Azad, 1992). However, in the present studies, efficacy of carbendazim was not comparable with the triazoles in controlling the disease.

Dry fruit yield:

Pooled data (Table 1) on yield of dry chilli fruits indicated that all the treatments were significantly superior over unsprayed control in improving the yield. Increase in yield due to various fungicides ranged from 29.94 to 67.16% over

Table 1: Efficacy of triazoles and other fungicides against fruit rot of chilli (pooled data for *Kharif*, 2009 to *Kharif*, 2011)

Treatments	Fruit rot incidence		Fruit rot severity		Dry fruit yield	
	Incidence (%)	Disease reduction over control (%)	PDI (%)	Disease reduction over control (%)	Yield (q ha^{-1})	Yield increased over control (%)
Tebuconazole 25% @ 0.1%	23.56 (28.92)	69.96	17.16 (24.19)	73.56	25.91	67.16
Difenconazole 25% @ 0.1%	27.22 (31.30)	65.30	19.29 (25.81)	70.27	25.71	65.87
Hexaconazole 5% @ 0.1%	29.67 (32.82)	62.17	20.80 (26.96)	67.95	25.41	63.94
Tricyclazole 75% @ 0.1%	37.78 (37.84)	51.84	28.80 (32.34)	55.62	24.24	56.39
Propiconazole 25% @ 0.1%	62.00 (52.05)	20.96	52.98 (46.73)	18.35	20.14	29.94
Mancozeb 75% @ 0.25%	46.78 (43.12)	40.36	36.53 (37.08)	43.70	22.29	43.81
Propineb 70% @ 0.15%	45.78 (42.52)	41.64	34.67 (35.99)	46.57	22.52	45.29
Copper oxychloride 50% @ 0.25%	57.11 (49.17)	27.19	45.16 (42.20)	30.41	20.65	33.23
Carbendazim 50% @ 0.1%	54.33 (47.60)	30.74	42.67 (40.76)	34.24	20.99	35.42
Unsprayed control	78.44 (62.91)	--	64.89 (53.91)	--	15.50	--
S. Em ±	1.35		1.87		1.36	
C.D. (P=0.05)	3.91		5.31		3.84	

Figures in parentheses are angular transformed values

Table 2 : Net return and benefit-cost ratio due to various fungicides applied for controlling fruit rot disease of chilli

Treatments	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})*	Gross monetary returns (Rs. ha^{-1})	Profit (Rs. ha^{-1})	Benefit: Cost ratio
Tebuconazole 25% @ 0.1%	25.91	62623.00	181370.00	118747.00	2.89
Difenconazole 25% @ 0.1%	25.71	64723.00	179970.00	115247.00	2.78
Hexaconazole 5% @ 0.1%	25.41	60283.00	177870.00	117587.00	2.95
Tricyclazole 75% @ 0.1%	24.24	64123.00	169680.00	105557.00	2.65
Propiconazole 25% @ 0.1%	20.14	61803.00	140980.00	79177.00	2.28
Mancozeb 75% @ 0.25%	22.29	60123.00	156030.00	95907.00	2.60
Propineb 70% @ 0.15%	22.52	63423.00	157640.00	94217.00	2.49
Copper oxychloride 50% @ 0.25%	20.65	59748.00	144550.00	84802.00	2.42
Carbendazim 50% @ 0.1%	20.99	59223.00	146930.00	87707.00	2.48
Unsprayed control	15.50	55923.00	108500.00	52577.00	1.94

*= Cost of cultivation includes production cost and cost of protection (Efficacy of sprayer- 5000 m^2/ day; rent for sprayer- Rs. 25/day; labour charges- Rs. 300/4000 m^2; cost of fungicides- Tebuconazole: Rs. 1750/l, Difenconazole: Rs. 2800/l, Hexaconazole: Rs. 580/l, Tricyclazole: Rs. 2500/kg, Propiconazole: 1340/l, Mancozeb: Rs. 480/kg, Propineb: Rs. 600/kg, Copper oxychloride: Rs. 380/kg and Carbendazim: Rs. 600/kg).
Sale price of dry chilli fruits: Rs. 7000/q

unsprayed control. The highest dry fruit yield of 25.91 q ha^{-1} was recorded in plots sprayed with tebuconazole and was at par with the yield recorded in the plots sprayed with difenconazole, hexaconazole, tricyclazole, propineb and mancozeb. The lowest yield of 15.50 q ha^{-1} was obtained in the unsprayed control plots.

Generally application of systemic fungicides results in higher yield, depending upon the quantum of disease and degree of control (Dickinson, 1981). In the present study likewise sprays of fungicides decreased the disease and increased the yield significantly. Gopinath *et al.* (2006) reported increase in fruit yield of chilli in the range of 86, 63 and 60% for propiconazole, difenconazole and carbendazim, respectively, when compared to unsprayed control. Griffiths and Scott (1977), Eswaramurthy *et al.* (1988) and Datar *et al.* (1990) also reported increased yield by systemic fungicides. As in the present investigation, Rathore (2004) also obtained highest dry fruit yield of chilli in the plots sprayed with difenconazole.

Benefit: Cost ratio:

The theme of fungicidal control of plant diseases should always be emphasized on economy of the fungicide. Data in regard to economics analysis presented in Table 2 revealed that the maximum benefit-cost (B:C) ratio of 2.95 was recorded in the treatment where chilli crop was protected with hexaconazole, followed by the treatment where the crop was protected with sprayings of tebuconazole, which gave B:C ratio of 2.89.

Although the maximum increase in yield was obtained by spraying tebuconazole, the maximum benefit:cost ratio could be obtained with hexaconazole. It means that tebuconazole though increases the yield, the cost of fungicide could not be yet met out with the increased yield. Conclusively, hexaconazole treatment is most economical and effective for management of the disease.

The present investigation, therefore, reveals that four sprayings of hexaconazole 5% SC at the concentration of 0.1%, first in the early fruiting stage and subsequent three sprays at 14 days' interval, are most effective and economical for controlling fruit rot disease of chilli under Maharashtra conditions.

REFERENCES

Anonymous (2009). In: *Krishidarshani*, 2009. (Kokate, Kiran; Ahire, Milind; Kharde, Pandit; Patil, Sandip and Chavai, Anand, Eds.). Directorate of Extension Education, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, (M.S.) INDIA pp. 116-117.

Azad, P. (1992). Efficacy of certain fungitoxicants against *Colletotrichum capsici* (Syd.) Butler and Bisby, the incitant of ripe fruit rot of chilli. *J. Assam Sci. Soc.*, **34** (2): 34–39.

Bosland, P.W. and Votava, E.J. (2003). *Peppers: vegetable and spice capsicums.* C.A.B. International, England, p. 233.

Chander Mohan, Thind, T.S., Prem Raj and Arora, J.K. (2004). Promising activity of triazoles and other fungicides against fruit rot of chilli and Stemphylium blight of onion. *Pl. Dis. Res.,* **19** (2) : 200-203.

Datar, V.V., Sontakke, M.B., Purandare, N.D. and Shinde, N.N. (1990). Fungicidal control of anthracnose of chillies. *Indian J. Mycol. Pl. Pathol.,* **20** (2) : 156-158.

Dickinson, C.H. (1981). Interaction of fungicides with minor pathogens on cereals. *EPPO Bull.,* **11**: 311.

Eswaramurthy, S., Pappiah, C.M., Muthusamy, M., Muthusamy, S., Mariappan, V., Jeysekar, R., Natrajan, S., David, P.M.M. and Gomathinayagam, P. (1988). Chemical control of die-back and fruit rot of chillies. *Pesticides,* **22** : 38-40.

Gopinath, K., Radhakrishnan, N.V. and Jayaraj, J. (2006) Effect of propiconazole and difenoconazole on the control of anthracnose of chilli fruits caused by *Colletotrichum capsici. Crop Prot.,* **25**(9): 1024-1031.

Griffiths, E. and Scott, S.W. (1977). Possible phytotoxic effects of fungicide on barley. In: E. McFarlane (ed.) *Crop protection agents-their biological evaluation*, Acdemic Press, London, pp. 466-478.

Hadden, J.F. and Black, L.L., (1989). Anthracnose of pepper caused by *Colletotrichum* spp. Proceeding of the International Symposium on integrated management practices: tomato and pepper production in the Tropics. Asian Vegetable Research and Development Centre, Taiwan, pp. 189-199.

Isaac, S. (1992). *Fungal plant interaction*. Chapman and Hall Press, London, p.115.

Jharia, H.K., Khare, M.N. and Chand, Amar (1977). Efficacy of fungicides in the control of fungal diseases of chillies. *Indian Phytopath.,* **39**: 341-343.

Kadu, I. K., More, B. B. and Utikar, P. G. (1977). Laboratory and field evaluation of fungicides against *Colletotrichum capsici*, the incitant of anthracnose of chilli. *Pesticides,* **11**: 19.

Kaur, Mandeep, Sharma, O. P. and Sharma, P. N. (2005). Identification of sources of resistance against virulences of *Colletotrichum capsici* causing fruit rot of chilli (*Capsicum annuum* L.). *Indian Phytopath.,* **58** (2): 232-234.

Manandhar, J.B., Hartman, G.L. and Wang, T.C. (1995). Anthracnose development on pepper fruits inoculated with *Colletotrichum gloeosporioides*. *Plant Dis.,* **79** (4) : 380-383.

McKinney, H. H. (1923). A new system of grading plant diseases. *J. Agric. Res.,* **26**: 195-218.

Mishra, D. (1988). Fungicides control of anthracnose and fruit rot of chilli. *Indian J. Agric. Sci.,* **58**(2): 147–149.

More, T.A. (2002). *Research recommendations in horticulture.* MPKV Res. Pub. P. 40, pp. 99-101.

Pakdeevaraporn, P., Wasee, S., Taylor, P.W.J. and Mongkolporn, O. (2005). Inheritance of resistance to anthracnose caused by *Colletotrichum capsici* in *Capsicum*. *Plant Breeding,* **124**(2) : 206-208.

Rathore, B.S. (2004). Performance of some new fungicides in controlling dieback and fruit rot of red pepper. *Pl. Dis. Res.*, **19**(2): 196-199.

Schultz, U. and Scheinpflug, H. (1988). In: *Sterol biosynthesis inhibitors – Pharmaceutical and agrochemical aspects* (D. Berg and M. Plempel, Eds.). Ellis Horwood, England, pp. 211-216.

Sharma, Y. K. and Thakore, B. B. L. (1999). Control of die-back of chillies with iprobenphos and its residues. *J. Mycol. Pl. Pathol.*, **29** (3): 294-298.

Than, P.P., Jeewon, R., Hyde, K.D., Pongsupasamit, S., Mongkolporn, O. and Taylor, P.W.J. (2008). Characterization and pathogenicity of *Colletotrichum* species associated with anthracnose disease on chilli (*Capsicum* spp.) in Thailand. *Plant Pathology*, **57**(3):562-572.

Thind, T.S. and Jhooty, J.S. (1985). Relative prevalence of fungal diseases of chilli fruits in Punjab. *Indian J. Mycol. Pl. Pathol*., **15** (3) : 305-307.

Thind, T.S. and Jhooty, J.S. (1987). Relative performance of some fungicides in controlling anthracnose and black rot of chillies. *Indian Phytopath.*, **40** (4) : 543-545.